Chapter Five

Convert Decimal to Binary &

Binary to Decimal Numbers Systems

٥.١ Introduction

When we type some letters or words, the computer translates them in numbers as computers can understand only numbers. A computer can understand the positional number system where there are only a few symbols called digits and these symbols represent different values depending on the position they occupy in the number.

The value of each digit in a number can be determined using -

- The digit
- The position of the digit in the number
- The base of the number system (where the base is defined as the total number of digits available in the number system)

Decimal Number System

The number system that we use in our day-to-day life is the decimal number system. Decimal number system has base ١٠ as it uses ١٠ digits from ٠ to ٩. In decimal number system, the successive positions to the left of the decimal point represent units, tens, hundreds, thousands, and so on.

Each position represents a specific power of the base (١٠). For example, the decimal number ١٢٣٤ consists of the digit ٤ in the units position, ٣ in the tens position, ٢ in the hundreds position, and ١ in the thousands position. Its value can be written as

(١x١٠٠٠)+ (٢x١٠٠)+ (٣x١٠)+ (٤xl)

(١x١٠٣)+ (٢x١٠٢)+ (٣x١٠١)+ (٤xl٠٠)

١٠٠٠ + ٢٠٠ + ٣٠ + ٤

١٢٣٤

Binary Number System

Characteristics of the binary number system are as follows:

- Uses two digits, ٠ and ١
- Also called as base ٢ number system
- Each position in a binary number represents a ٠ power of the base (٢). Example (٠)٢
- Last position in a binary number represents a x power of the base (٢). Example ٢x where x represents the last position – ١

٥,٢ Convert Binary to Decimal System

Step ١ - Determine the column (positional) value of each digit (this depends on the position of the digit and the base of the number system)
Step ٢ - Multiply the obtained column values (in Step ١) by the digits in the corresponding columns.
Step ٣ - Sum the products calculated in Step ٢. The total is the equivalent value in decimal.

Example -١-

Binary Number: $١١١٠١_{٢}$

Calculating Decimal Equivalent:

Step	Binary Number	Decimal Number
Step ١	$١١١٠١_{٢}$	$((١ \times ٢^{٤}) + (١ \times ٢^{٣}) + (١ \times ٢^{٢}) + (٠ \times ٢^{١}) + (١ \times ٢^{٠}))_{١٠}$
Step ٢	$١١١٠١_{٢}$	$(١٦ + ٨ + ٤ + ٠ + ١)_{١٠}$
Step ٣	$١١١٠١_{٢}$	$٢٩_{١٠}$

Binary Number: $١١١٠١_{٢}$ = Decimal Number: $٢٩_{١٠}$

Note: $١٠١٠١_{٢}$ are normally written as ١٠١٠١.

٥,٣ Convert Decimal to Binary System

Step ١ - Divide the decimal number to be converted by the value of the new base.
Step ٢ - Get the remainder from Step ١ as the rightmost digit (least significant digit) of the new base number.
Step ٣ - Divide the quotient of the previous divide by the new base.
Step ٤ - Record the remainder from Step ٣ as the next digit (to the left) of the new base number.

Repeat Steps ٣ and ٤, getting remainders from right to left, until the quotient becomes zero in Step ٣.

Example-٢-

Decimal Number: $٢٩_{١٠}$.

Calculating Binary Equivalent:

Step	Operation	Result	Remainder
Step ١	٢٩ / ٢	١٤	١
Step ٢	١٤ / ٢	٧	٠
Step ٣	٧ / ٢	٣	١
Step ٤	٣ / ٢	١	١
Step ٥	١ / ٢	٠	١

As mentioned in Steps ٢ and ٤, the remainders have to be arranged in the reverse order so that the first remainder becomes the Least Significant Digit (LSD) and the last remainder becomes the Most Significant Digit (MSD).

Decimal Number: $٢٩_{١٠}$. = Binary Number: $١١١٠١_{٢}$

Example-٣-

Decimal Number: $٢١_{١٠}$.

Calculating Binary Equivalent:

Step	Operation	Result	Remainder
Step 1	21 / 2	10	1
Step 2	10 / 2	5	0
Step 3	5 / 2	2	1
Step 4	2 / 2	1	0
Step 5	1 / 2	0	1

Decimal Number: $٢١_{١٠}$. = Binary Number: $١٠١٠١_{٢}$

Decimal Numeral Numbers

- It is a based on the Arabic numeral system.
- It uses positional notation
- Use same symbols for different orders of magnitude, but in different places, e.g., ones place, tens place, hundreds place.
- Each next-place (order) digit adds $١٠^{٠}, ١٠^{١}, ١٠^{٢}, ١٠^{٣}$, etc.
- Example: In decimal, ١٤٧٢ means

٢ - is in the ones place so multiply it by ١٠٠ (١) = ٢

٧ - is in the tens place so multiply it by ١٠١ (١٠) =٧٠

٤ - is in the one-hundred place so multiply it by١٠٢(١٠٠) =٤٠٠

١ - is in the one-thousands place so multiply it by ١٠٣ (١٠٠٠) =١٠٠٠

١٠٠٠+٤٠٠+٧٠+٢=١٤٧٢

Binary Numeral Numbers

- It is a based on the binary representation (٠, ١).
- It also uses positional notation
- Use the same symbols for different orders of magnitude, but in different places, e.g., ones place, twos place, fours place.
- Each next-place (order) digit adds ٢٠,٢١,٢٢,٢٣, etc.
- Example: In binary, ١١٠١ means

١ - is in the ones place so multiply it by ٢٠ (١) = ١

٠ - is in the twos place so multiply it by ٢١ (٢) = ٠

١ - is in the fours place so multiply it by ٢٢ (٤) = ٤

١ - is in the eights place so multiply it by ٢٣ (٨) =٨

=> ٨+٤+٠+١ = ١٣

Binary ١١٠١ = Decimal ١٣

١١٠١ B = ١٣ D

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111

Binary	Decimal
0	0
1	1
10	2
100	4
1000	8
10000	16
100000	32
1000000	64